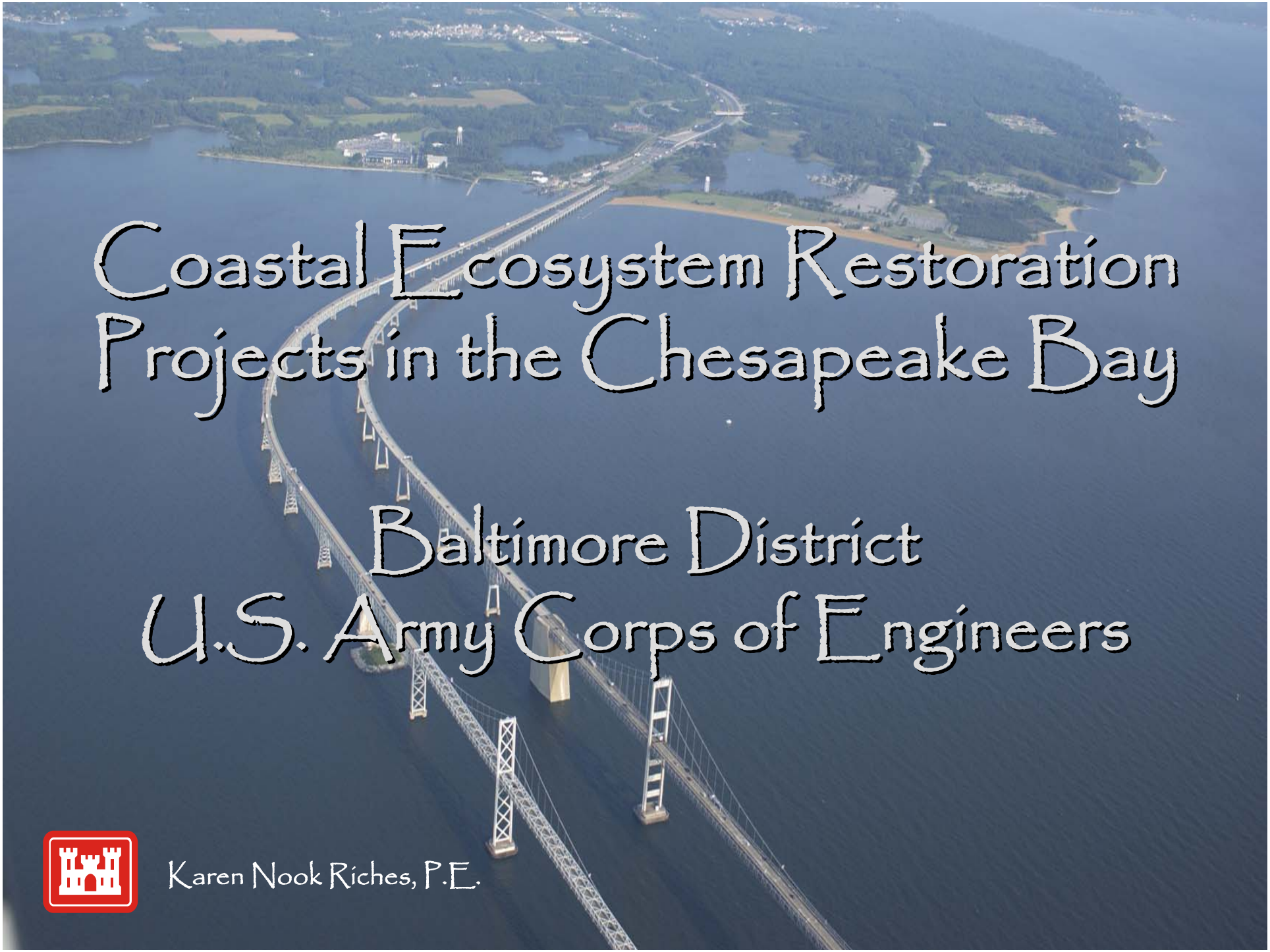


Coastal Ecosystem Restoration Projects in the Chesapeake Bay

Baltimore District
U.S. Army Corps of Engineers

Karen Nook Riches, P.E.

Chesapeake Bay

- Nation's largest estuary
  - 64,000 sq mi watershed
  - 200 miles long
  - 3.5 to 35 miles wide
  - 11,684 miles shoreline
- Partially mixed estuary
- Tide range 1-3 ft
- Salinity fresh to salt (3.5%)

Chesapeake Bay Ecosystem

- Blue Crab Nursery
- Productive Fishery
- Oysters and other Shellfish
- Waterfowl & Migratory Birds
- Mammals and Invertebrates
- Rare and Endangered Species

Human Uses of Chesapeake Bay

- Property and Infrastructure
  - Private (85%)
  - Public
- Waterborne Commerce
  - Port of Baltimore
- Commercial Fishing
- Recreation

Hurricane Isabel

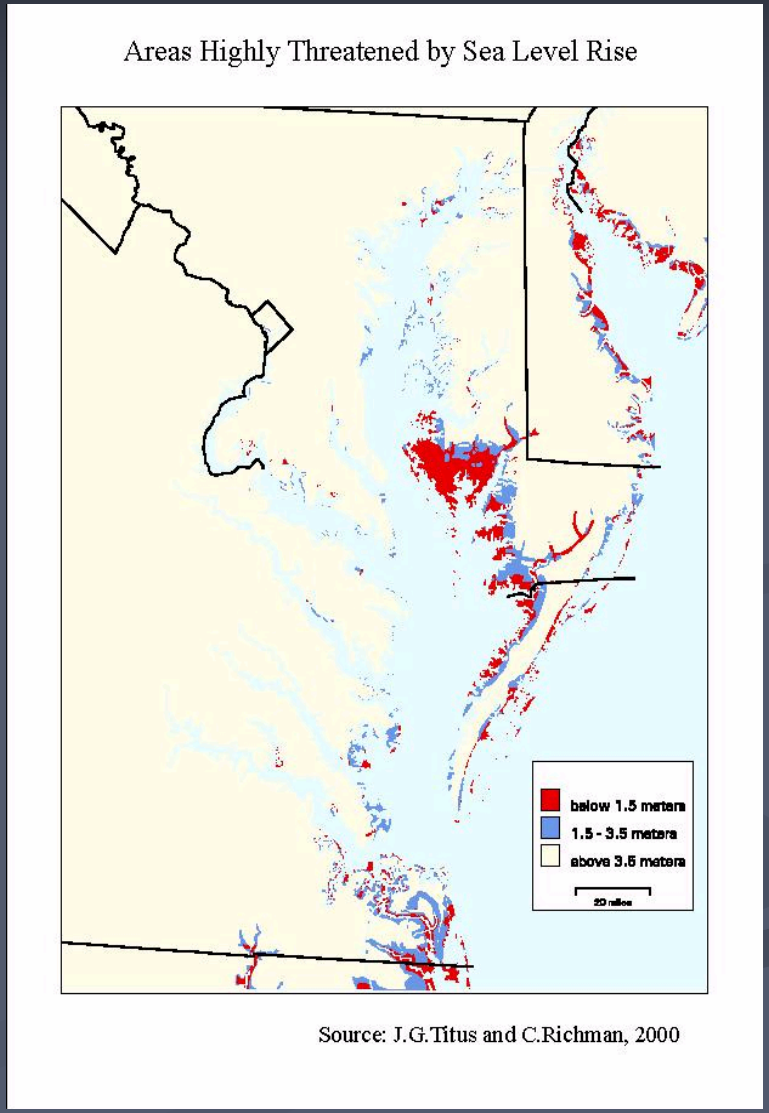
Factors Contributing to Erosion

Short Term

- Waves
- Tides & Currents
- Storms
- Surface Runoff
- Groundwater Seepage
- Subsidence
- Ice
- Anthropogenic

Long Term: Sea Level Rise

- 1 foot/century (3-4 mm/year)



Shoreline Erosion

Problems:

- Loss of Property & Infrastructure
- Shoreline Hardening
- Loss of Habitat
- Source of sediment to Bay
  - Estimated 11 mcy/yr in MD and V
    (4.7 mcy MD)
  - Reduced water clarity
  - Reduced light for SAV growth

Benefits:

- Source of sediment for downdrift beaches and wetlands

Traditional Corps Coastal Projects

Focus on human uses:

- Infrastructure protection

- Navigation

- **Small Projects (Continuing Authorities)**
  - Section 107 – Harbor Protection and Navigation
  - Section 14 – Emergency Shoreline Erosion Control
  - Section 103 – Storm Damage Protection
- **Baltimore Harbor Shipping Channels**
  - Maintenance Dredging
  - Dredged Material Management

Corps Coastal Ecosystem Projects

Focus on balancing human uses and ecosystem needs to ensure the sustainability of Chesapeake Bay resources

- **Small Projects (Continuing Authorities)**
  - Section 206 Ecosystem Restoration
  - Section 1135 Mitigation for Corps Projects
- **General Investigation Studies**
- **Dredged Material Management**
  - Dredged Material Management Plan (DMMP)
  - Beneficial Use of Dredged Material
- **Environmental Enhancements**

Coastal Ecosystem Restoration Projects

- **Natural "Living" Shorelines**
  - Tidal Wetlands (Freshwater & Brackish)
  - Vegetated Banks
- **Nearshore Habitat**
  - Submerged Aquatic Vegetation (SAV)
  - Mudflats
- **Island Habitat**
  - Uplands, Wetlands & Nearshore Habitat
- **Oyster Recovery**

Natural Shoreline Types

Ongoing Coastal Ecosystem Studies

- ***Shoreline Masterplan/Natural Shorelines***
  - Chesapeake Bay Shoreline Erosion Study
- ***Tidal Wetland Restoration***
  - Chesapeake Marsh Lands Study (Blackwater Refuge)
- ***Island Ecosystem Restoration & Beneficial Use of Dredged Material***
  - Mid-Chesapeake Bay Island Feasibility Study
  - Poplar Island Construction
  - Poplar Island Expansion Feasibility Study
- ***Oyster Recovery Program***
- ***SAV Restoration***

General Shoreline Classification

Factors Affecting Wave Energy

- Fetch
- Water Depth
- Shoreline Orientation
- Shoreline Type
- Nearshore slope

High-Energy Shorelines

- > 5 nautical miles
- Mainstem Bay
- Structural measures

Moderate-Energy Shorelines

- 1-5 nautical miles
- Main tributaries
- Combination measures

Low-Energy Shorelines

- <1 nautical mile
- Tidal creeks and minor tribs
- Non-structural measures

Shoreline Protection Measures

Structural

- Bulkheads/Seawalls
- Revetments/Sills
- Breakwaters
- Groins

Non-Structural

- Beachfill
- Tidal Wetlands
- Bank Revegetation
- Oyster Bar Reefs
- SAV Restoration

Combination

- Sill Protected Wetlands
- Offshore Breakwaters with Beachfill and Wetlands
- Headland breakwater systems
- Island Restoration
- Other Combinations

Structural Measures: Bulkheads and Seawalls

Materials

- Timber
- Metal
- Vinyl
- Concrete

Uses

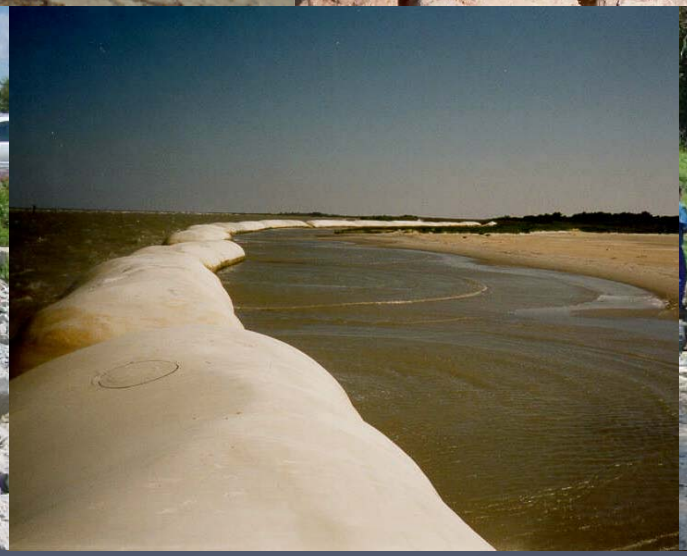
- Infrastructure Protection
- Harbor & Docks
- Soil retention
- Flooding

Tylertown, Smith Island, Maryland

Design Considerations

- Wave Reflection
- Toe scour
- Drainage
- Environmental impacts

Structural Measures: *Revetments*



Structural Measures: *Groins*

Uses

- Moderate to High Wave Energy
- Recreation Beach
- Property and Infrastructure Protection

Materials

- Stone
- Concrete
- Timber
- Geotextile Tubes

Mayo Beach Park, Maryland

Design considerations

- Not typically built due to effects on adjacent shorelines
- Flanking

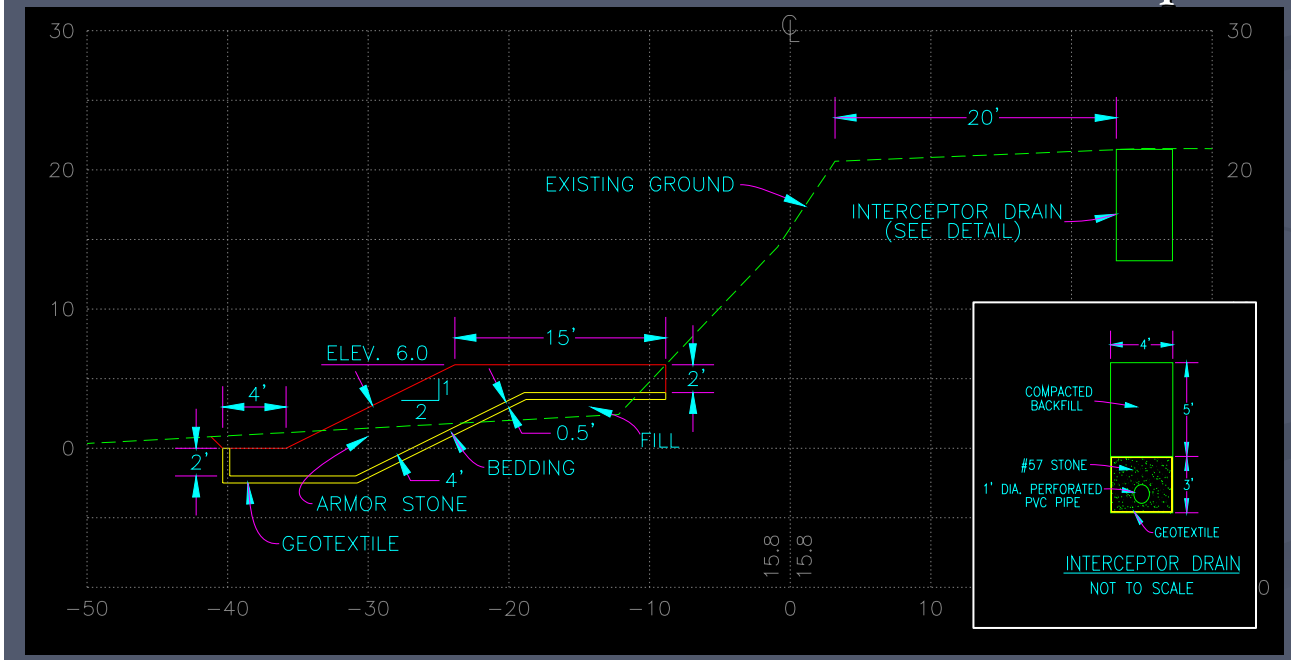
Combination Measures: *Revetment with Surface & Groundwater Drainage System*

Uses

- Moderate to High Wave Energy
- Critical Infrastructure Protection

Design Considerations

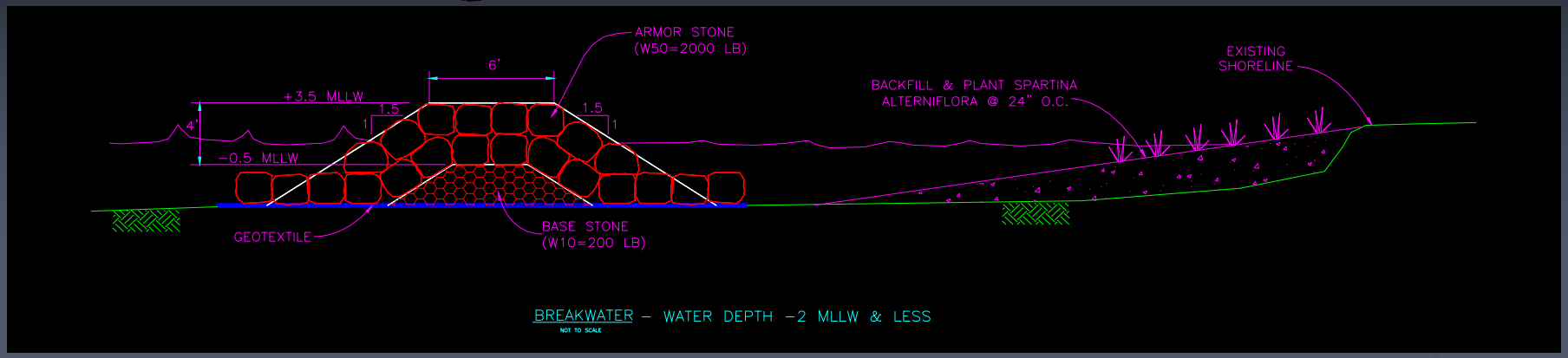
- Runup and Overtopping
- Wave Reflection
- Toe scour
- Drainage
- Impact to Nearshore Habitat



Materials

- Timber
- Metal
- Vinyl
- Concrete

Combination Measures: *Breakwaters with Beachfill & Wetlands*



Uses:

- **Moderate to High Wave Energy**
- **Property and Infrastructure Protection**
- **Wetland Protection/Creation**

Materials:

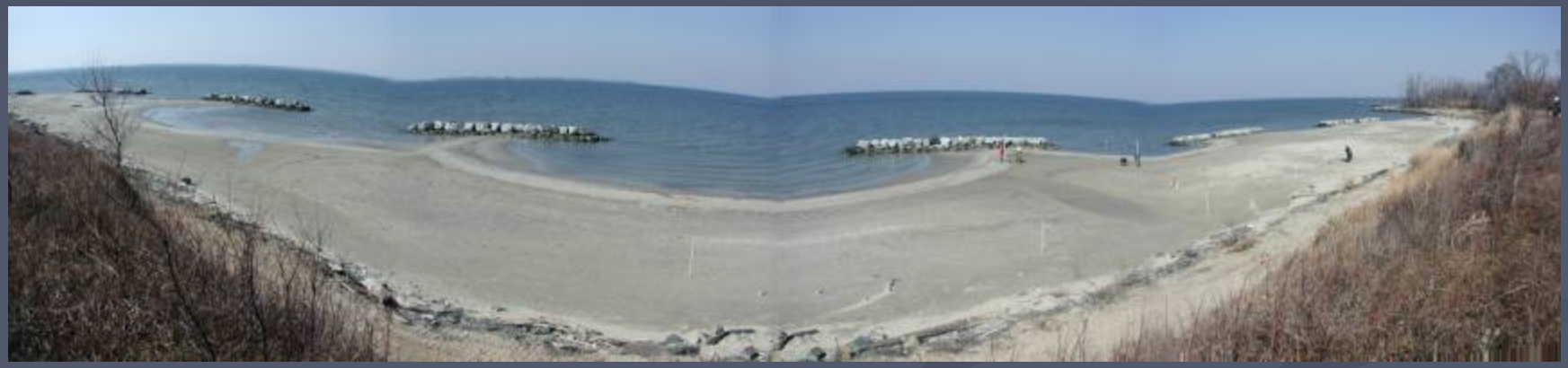
- **Stone**
- **Concrete**
- **Geotextile Tubes**

Design Considerations

- **Functional Performance**
  - Wave transmission, overtopping, and diffraction
  - Crest Elevation
  - Length, Gap Width, and Distance Offshore
  - Orientation
- **Structural Stability**
  - Toe Protection
  - Foundation Conditions
- **Impacts:**
  - Effect on Adjacent Shoreline
  - Nearshore Habitat Disturbance

Breakwaters with Tidal Marsh

Eastern Neck Wildlife Refuge



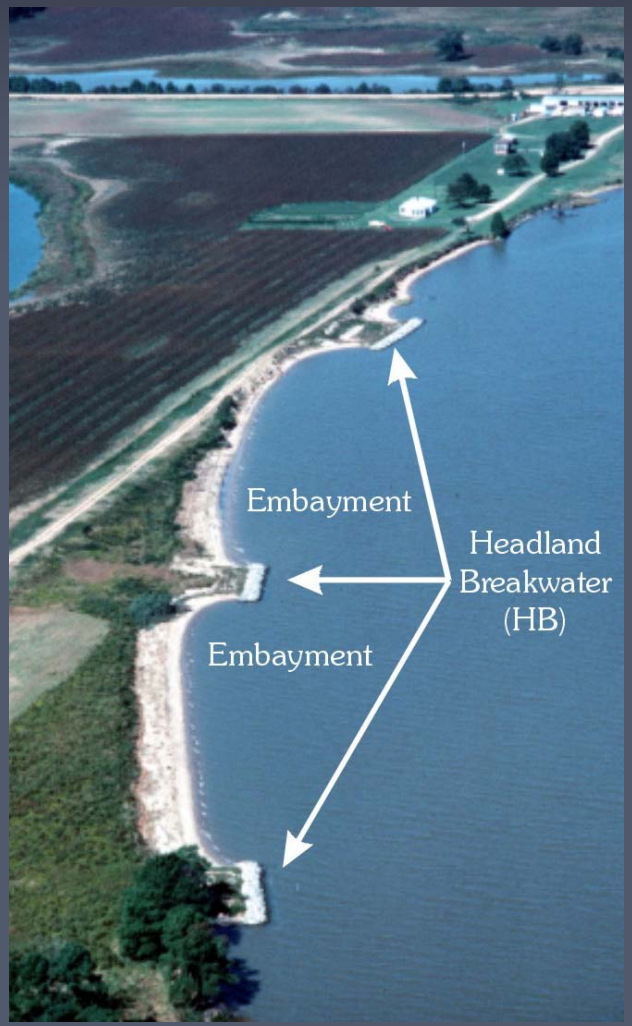
Breakwaters

Van Dyke– Burrells Bay, James River

Taylors Island, Maryland

West Bank, Isle of Wight Co., James River

Headland Control



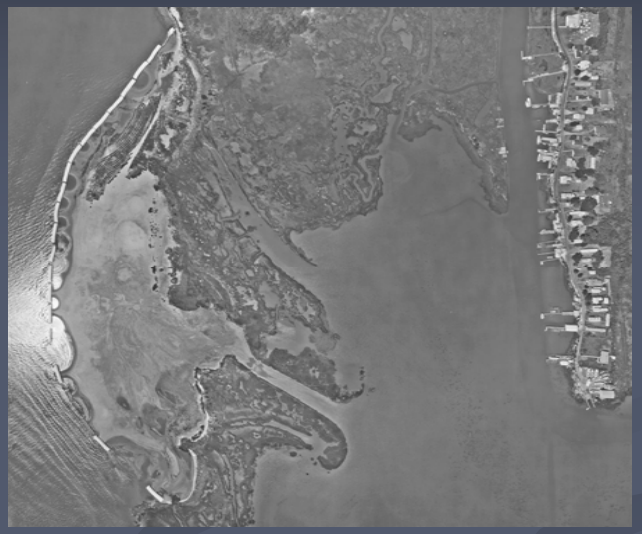

Summerille, Virginia – Smith Point


Hog Island, Surry Co. Virginia

Photos: VIMS

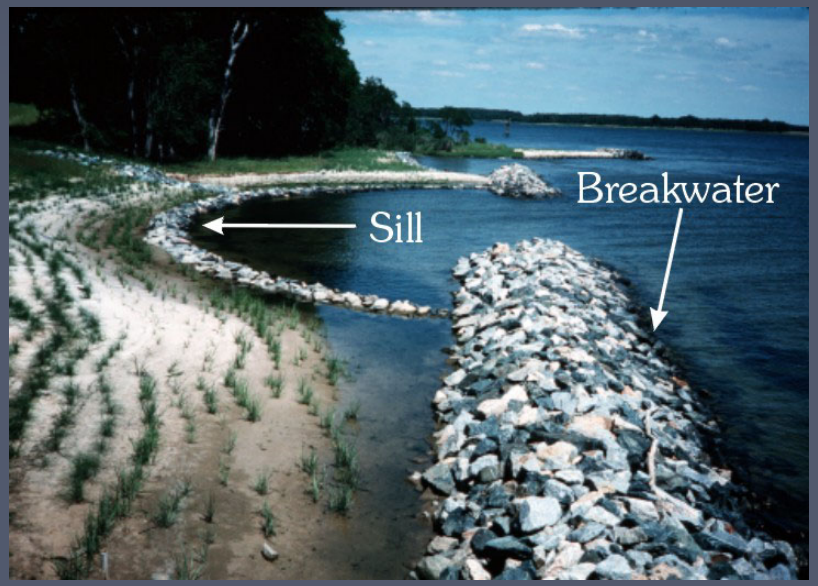
Combination: Wetland Creation Using Dredged Material and Sills

Geotextile Tubes for Revetments, Breakwaters, and Sills



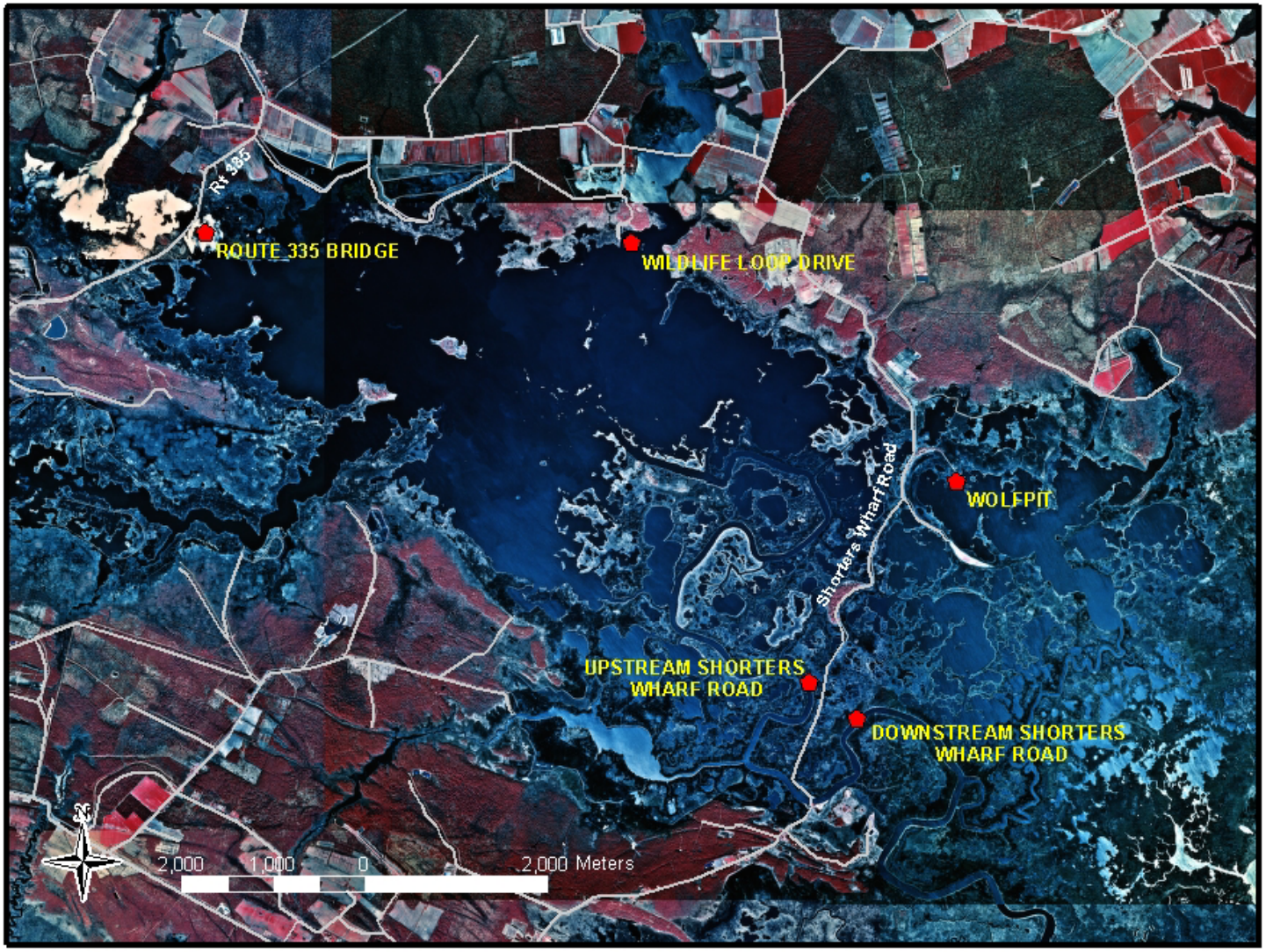
Failed Tubes at Smith Island, Maryland

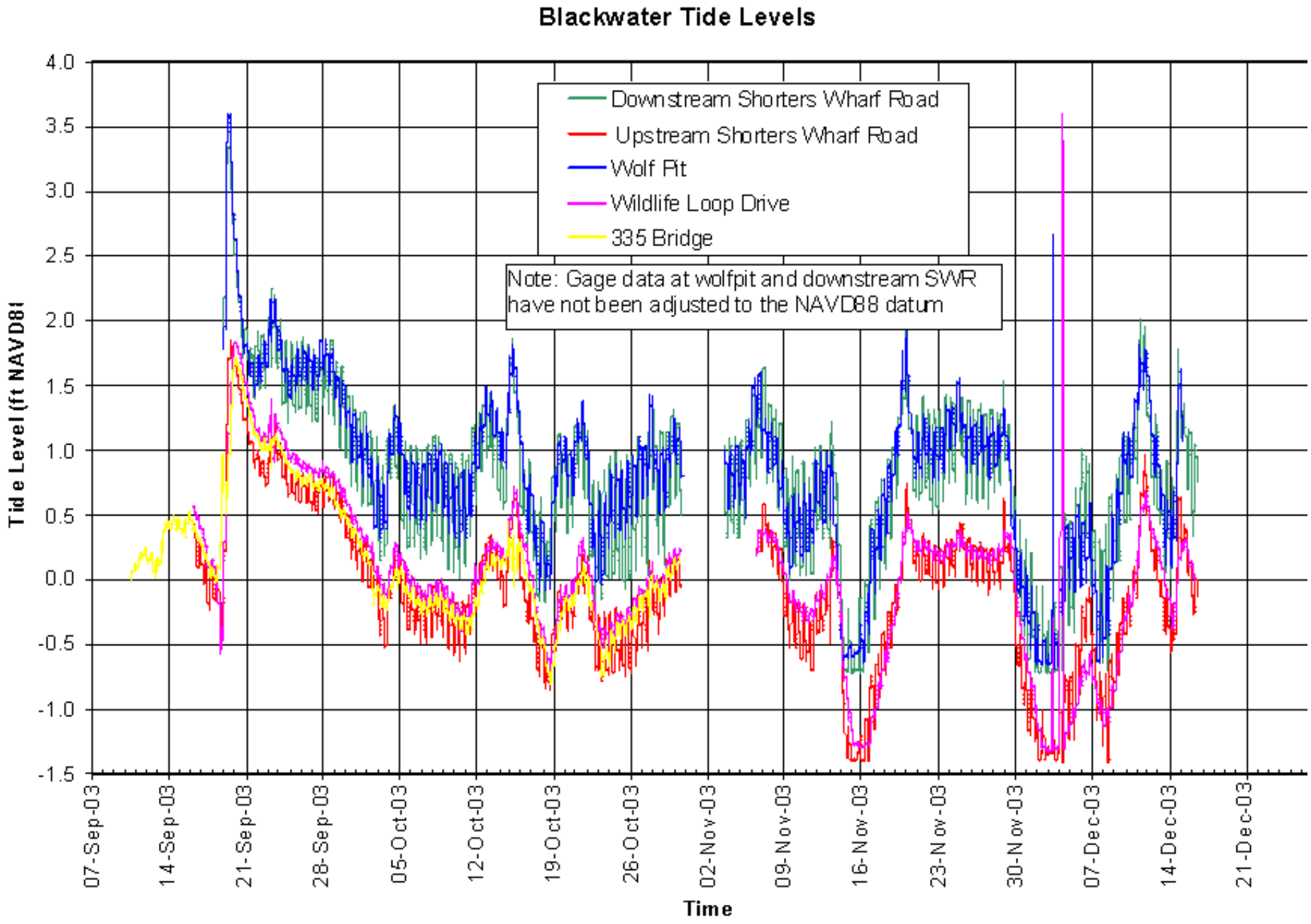
Combination: Breakwaters, Sills, Beachfill, and Wetlands



Chesapeake Marsh Lands Study

Tide Gages at Blackwater National Wildlife Refuge




Blackwater Tide Levels
Downstream Shorters Wharf Road
Upstream Shorters Wharf Road
Wolf Pit
Wildlife Loop Drive
335 Bridge
Note: Gage data at wolfpit and downstream SWR have not been adjusted to the NAVD88 datum
Tide Level (ft NAVD8
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
07-Sep-03
14-Sep-03
21-Sep-03
28-Sep-03
05-Oct-03
12-Oct-03
19-Oct-03
26-Oct-03
02-Nov-03
09-Nov-03
16-Nov-03
23-Nov-03
30-Nov-03
07-Dec-03
14-Dec-03
21-Dec-03
Time

Wetland Creation Using Dredged Material

Blackwater Marsh Restoration Demonstration Project

1859 Historical Map of Maryland

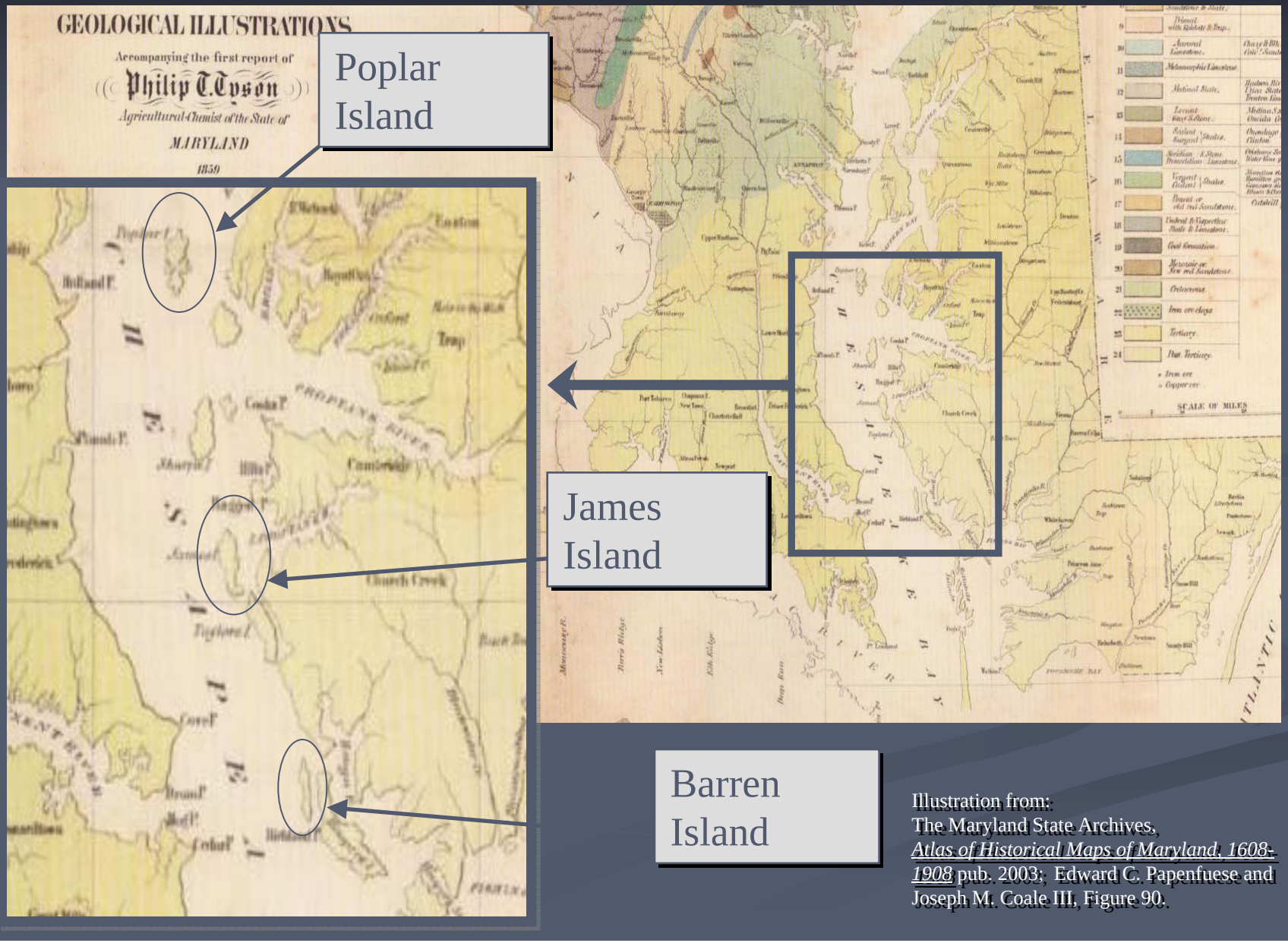


Illustration from:
The Maryland State Archives,
Atlas of Historical Maps of Maryland, 1608-1908 pub. 2003; Edward C. Papenfuese and Joseph M. Coale III, Figure 90.

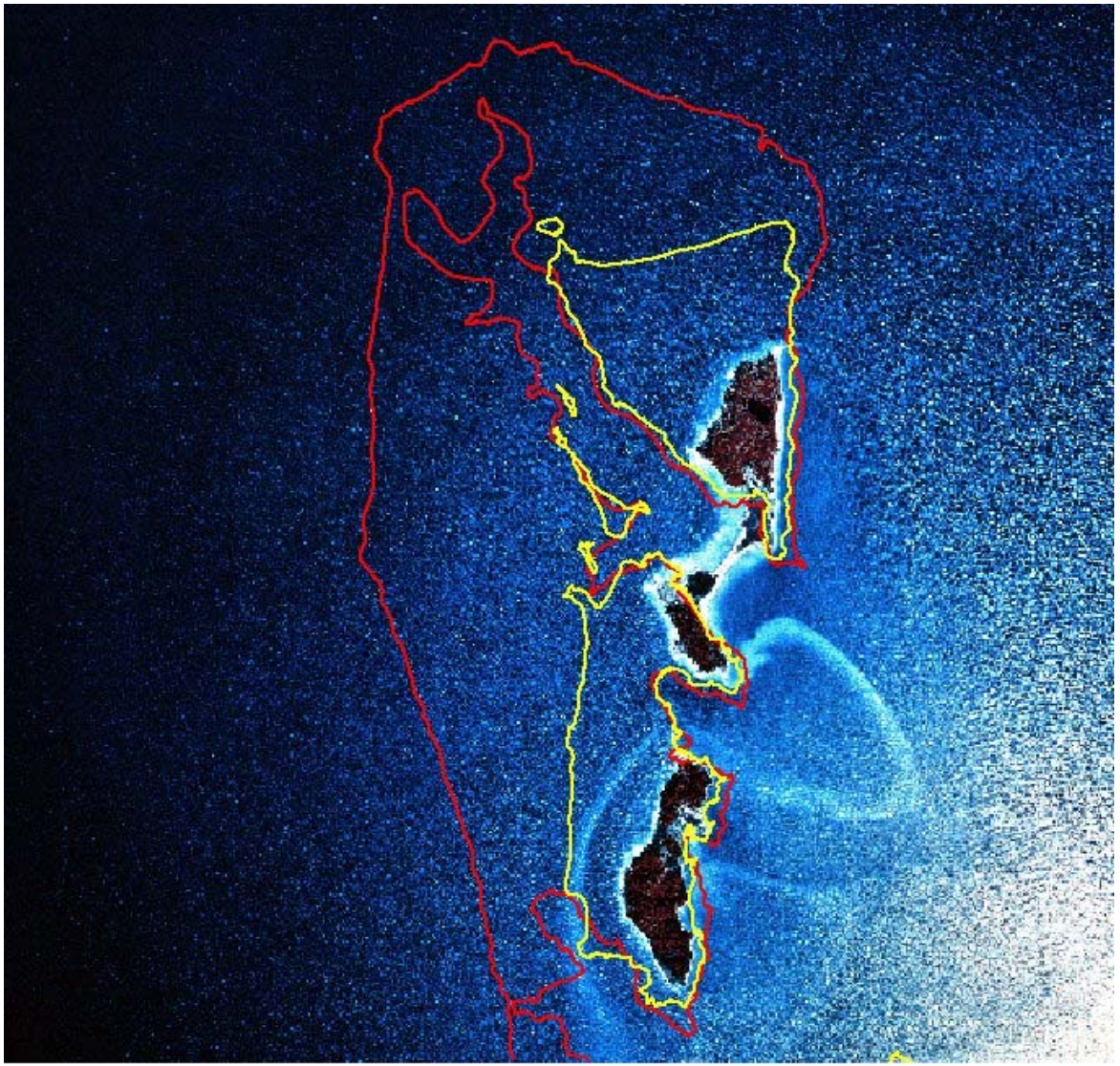
JAMES ISLAND (1847 - 1994)

147 years

976 acres (1847)

92 acres (1994)

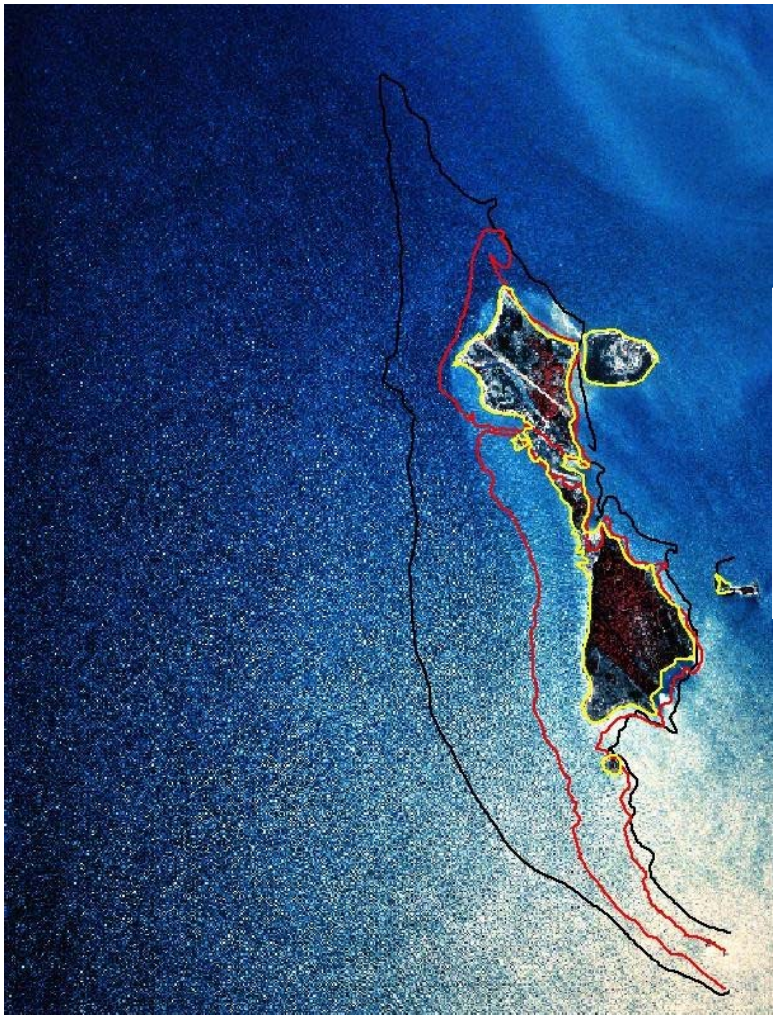
884 acres lost



Date of Photography: 1994

BARREN ISLAND (1847-1994)

147 Years



839 acres (1847)

175 acres (1994)

---

664 acres lost

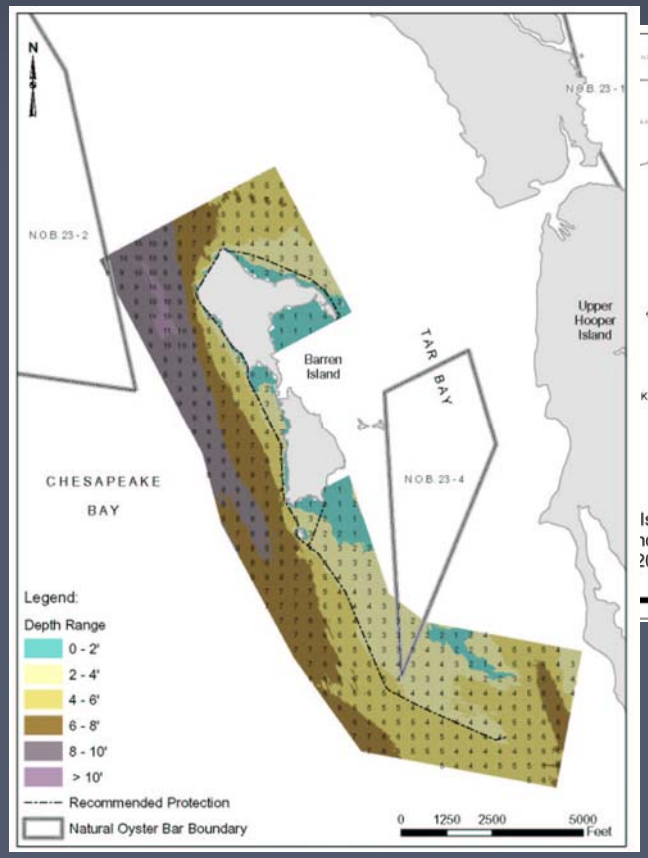
1847

1942

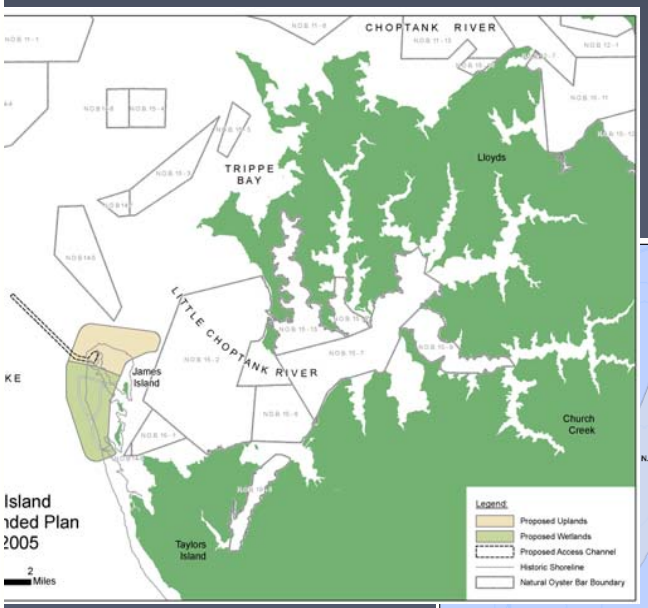
Date of photography 1994

Chesapeake Bay Island Restoration

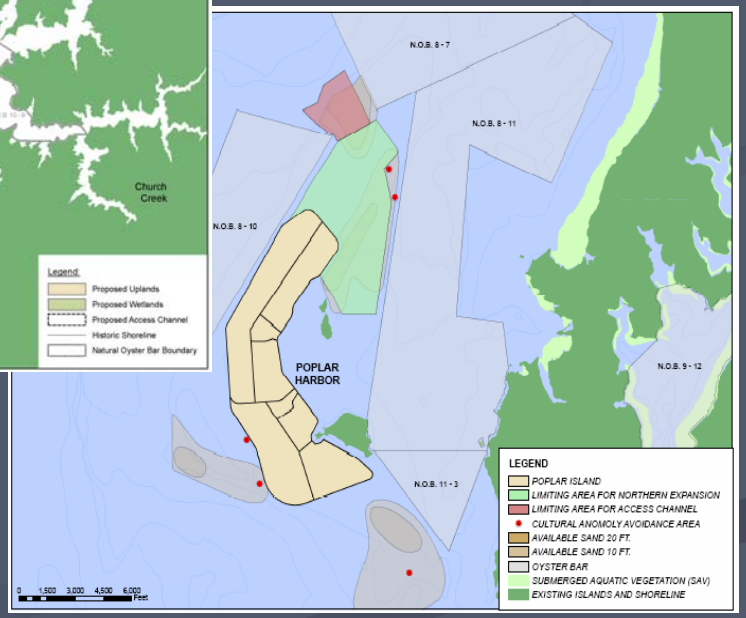
Project Goal: *To restore and protect valuable but threatened Mid-Chesapeake Bay island ecosystems through the beneficial use of dredged material*



Barren Island

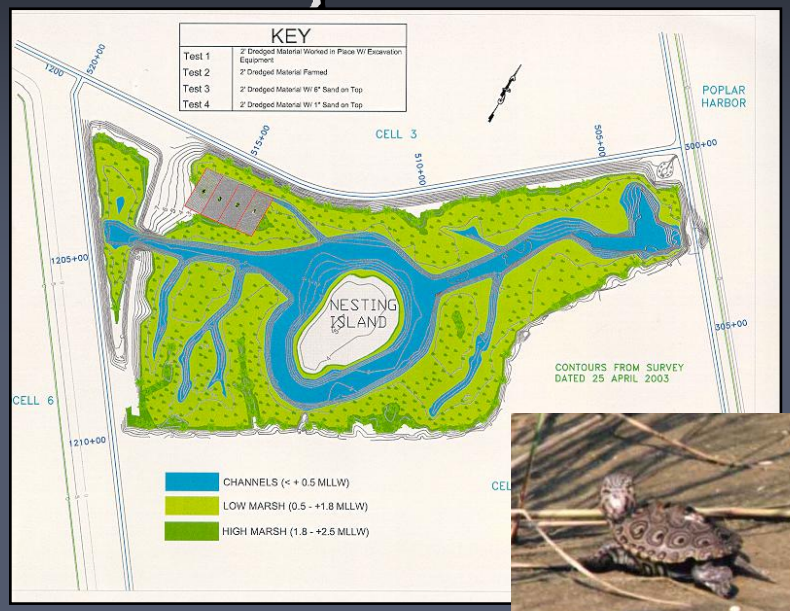


James Island



Poplar Island

Poplar Island Restoration

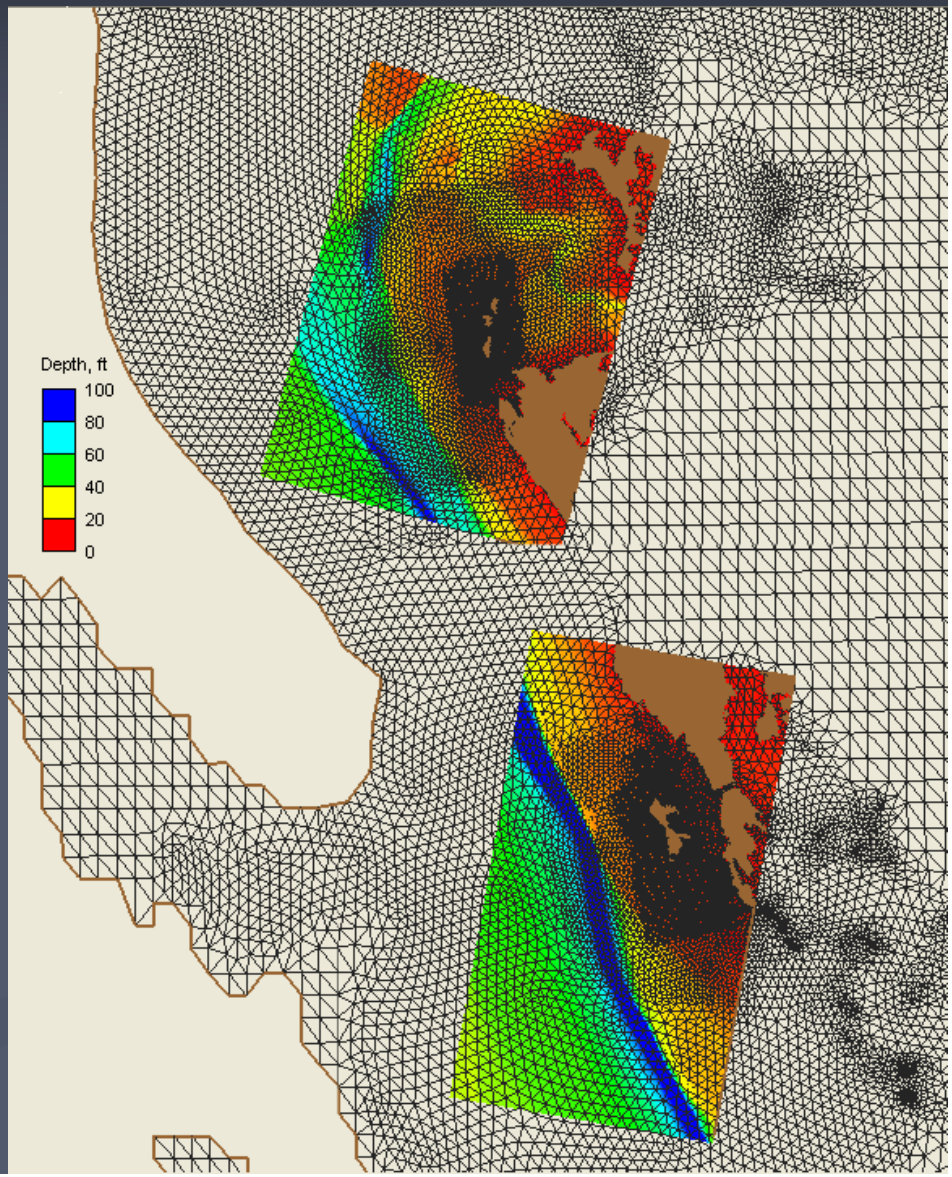



Poplar Island
Jefferson Island
Poplar Harbor
Cell 1
Cell 2
3D
Cell 3
Cell 4
Cell 5
Cell 6
Containment Dikes
Looking East

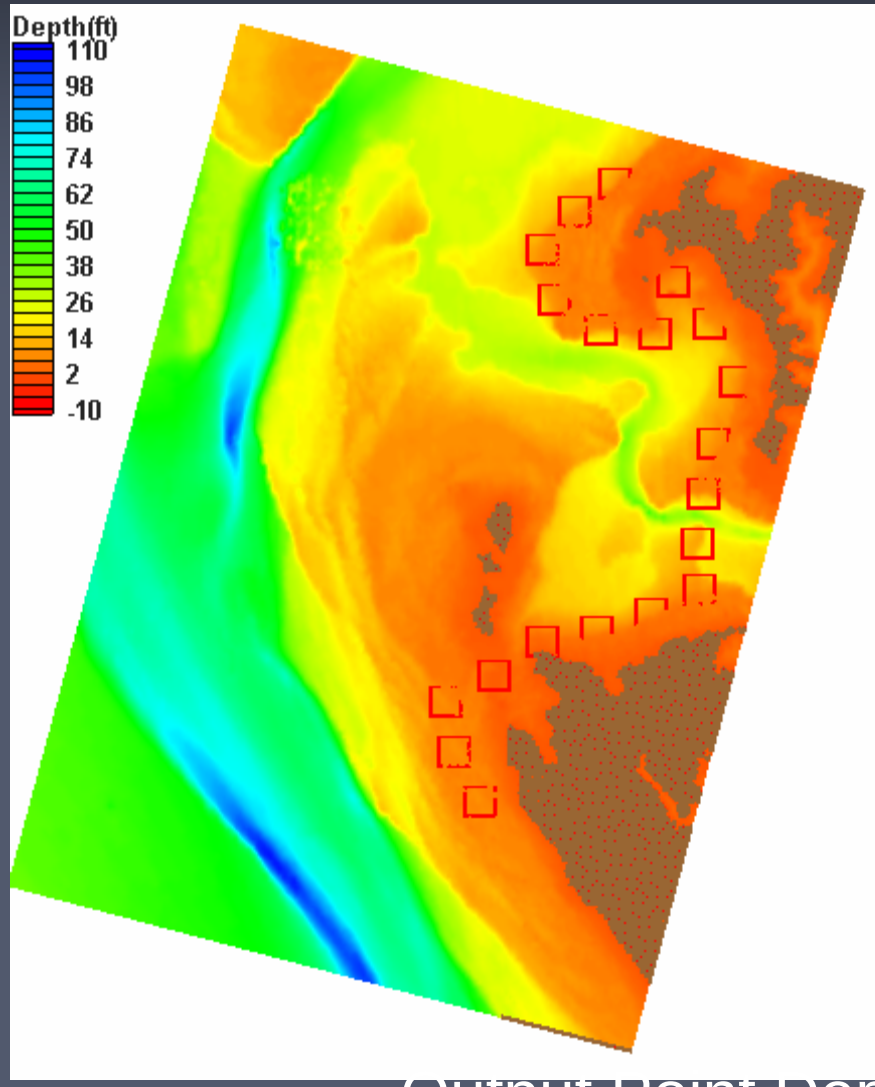

N
COACHES ISLAND
JEFFERSON ISLAND
POPLAR HARBOR
POPLAR ISLAND
0
1,000
2,000
3,000
4,000
Feet

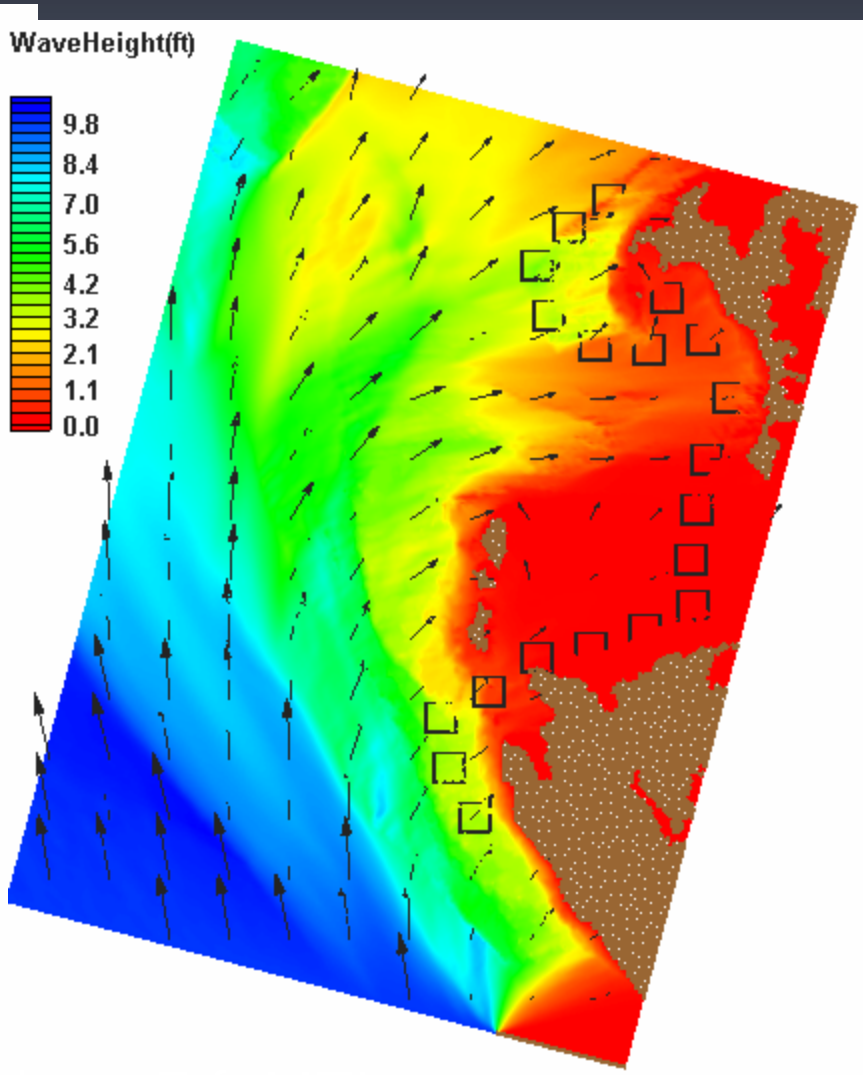
Coastal Modeling

- STWAVE & ADCIRC
- Evaluate project impacts on shoreline erosion and protection at James and Barren Islands
- Evaluate project impacts on water levels, current velocities, and sedimentation/accretion during storm events due to combined effects of wind and waves.
- Evaluate effectiveness of alternative tidal channel configurations at James Island on flushing, erosion, and sedimentation of the wetland
- Evaluate Barren Island alternatives for the maximum protection of SAV and minimum impacts to the Island, Honga River Channel, and Oyster ground



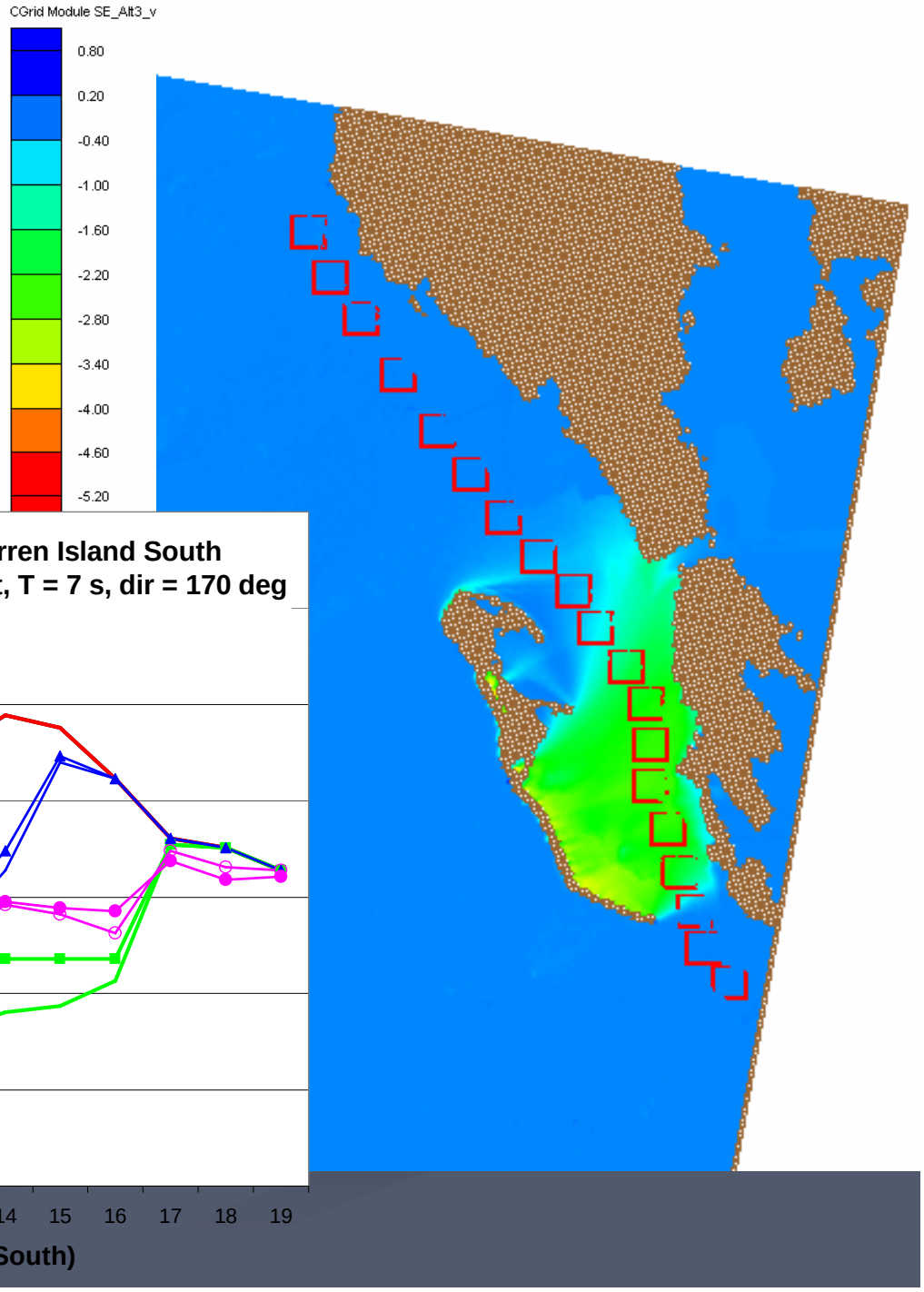
James Island Shoreline Impacts

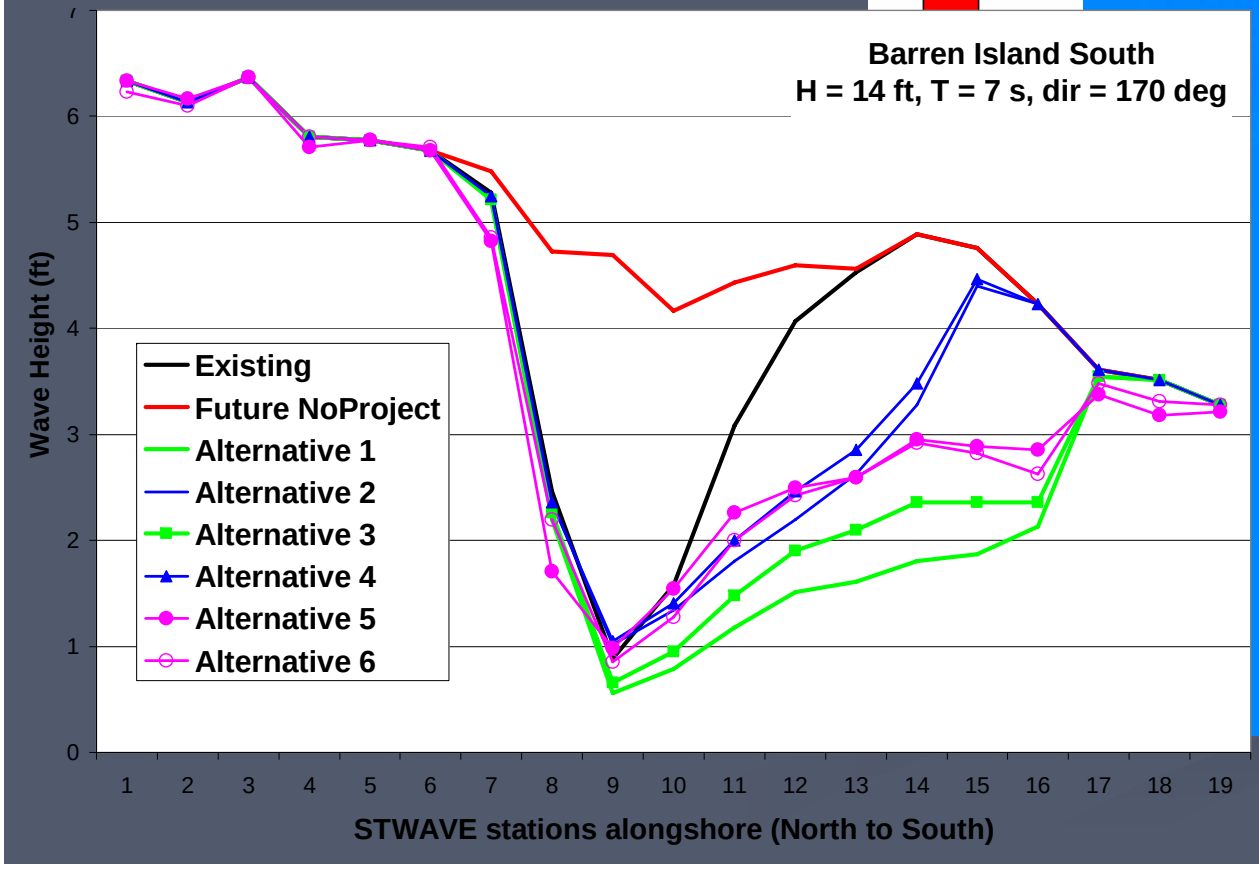




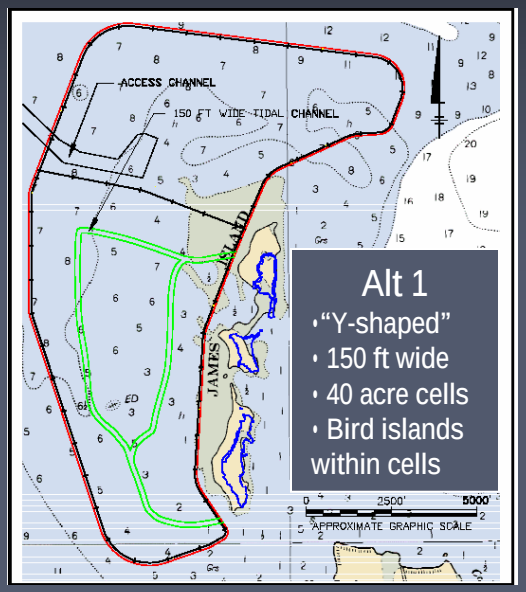
Output Point Depths ~ 7 ft MTL

Barren Island Shoreline Impacts

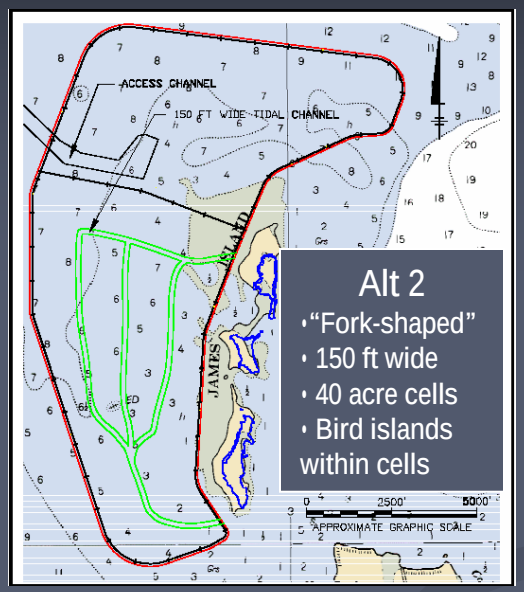




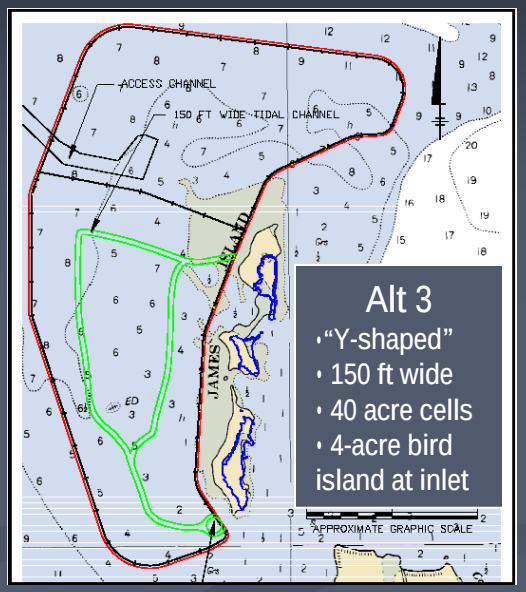
James Island Tidal Guts



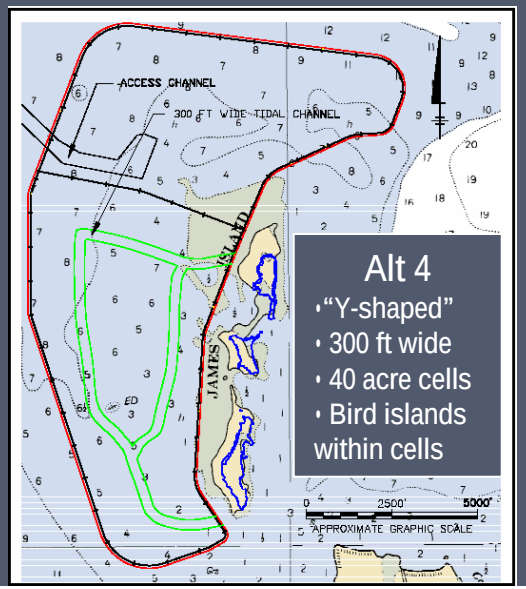
Alt 1
- "Y-shaped"
- 150 ft wide
- 40 acre cells
- Bird islands within cells



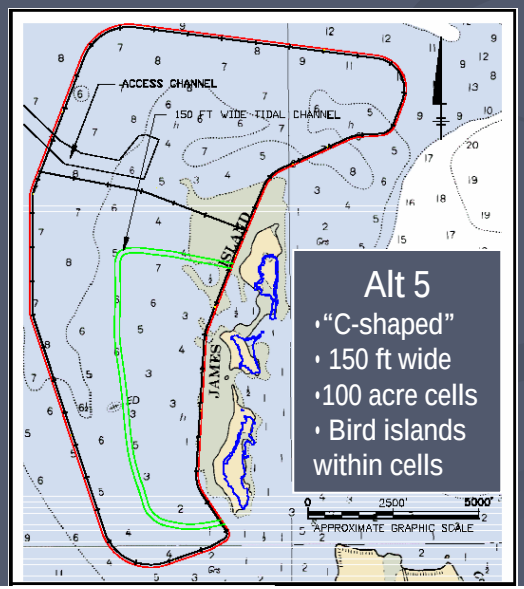
Alt 2
- "Fork-shaped"
- 150 ft wide
- 40 acre cells
- Bird islands within cells



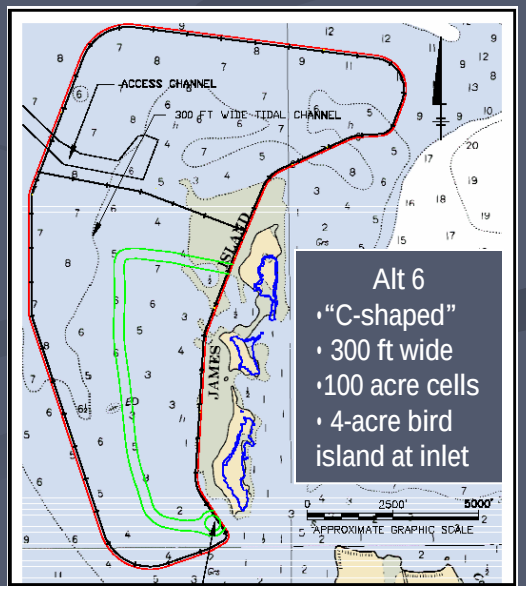
Alt 3
- "Y-shaped"
- 150 ft wide
- 40 acre cells
- 4-acre bird island at inlet



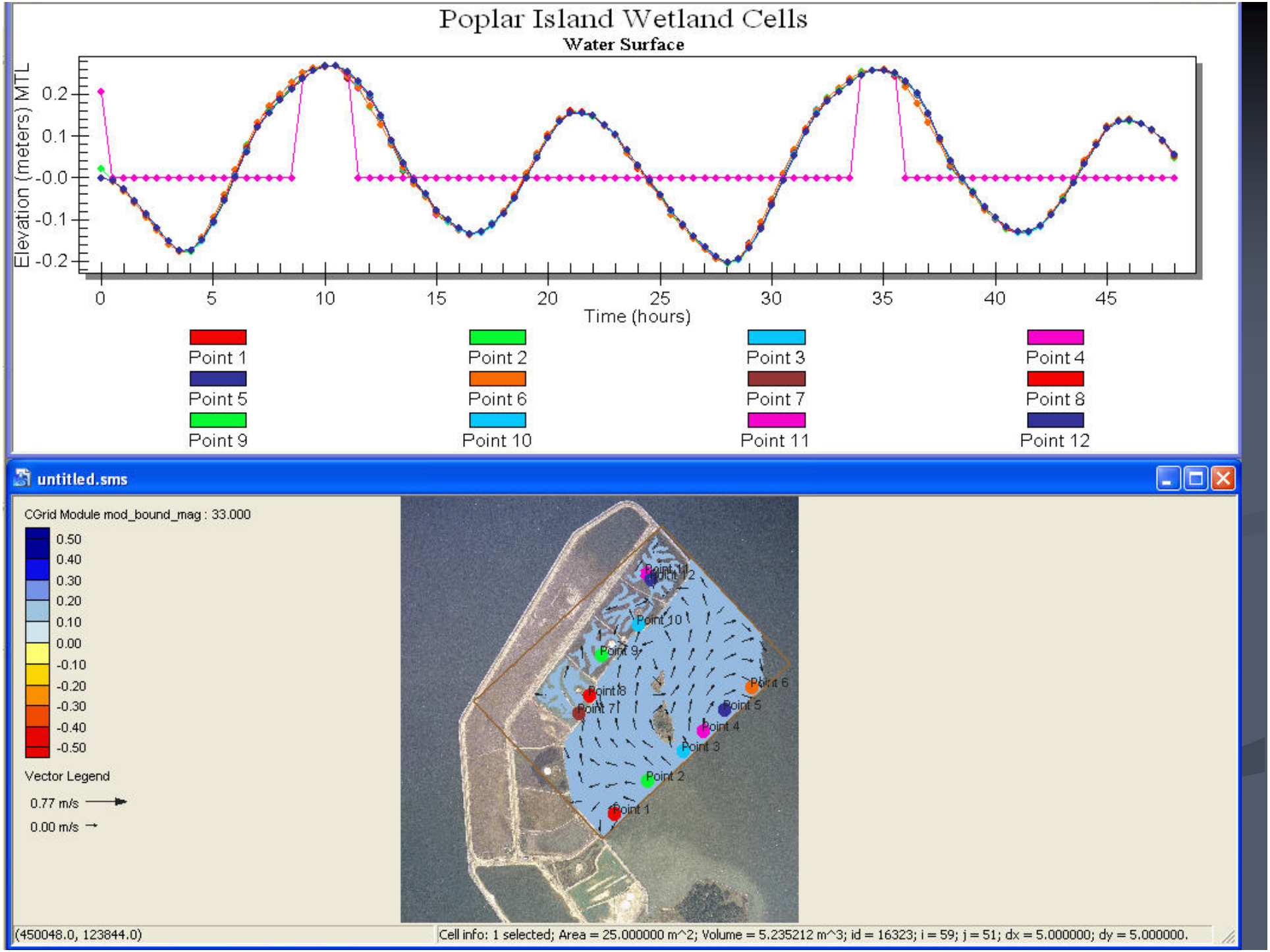
Alt 4
- "Y-shaped"
- 300 ft wide
- 40 acre cells
- Bird islands within cells

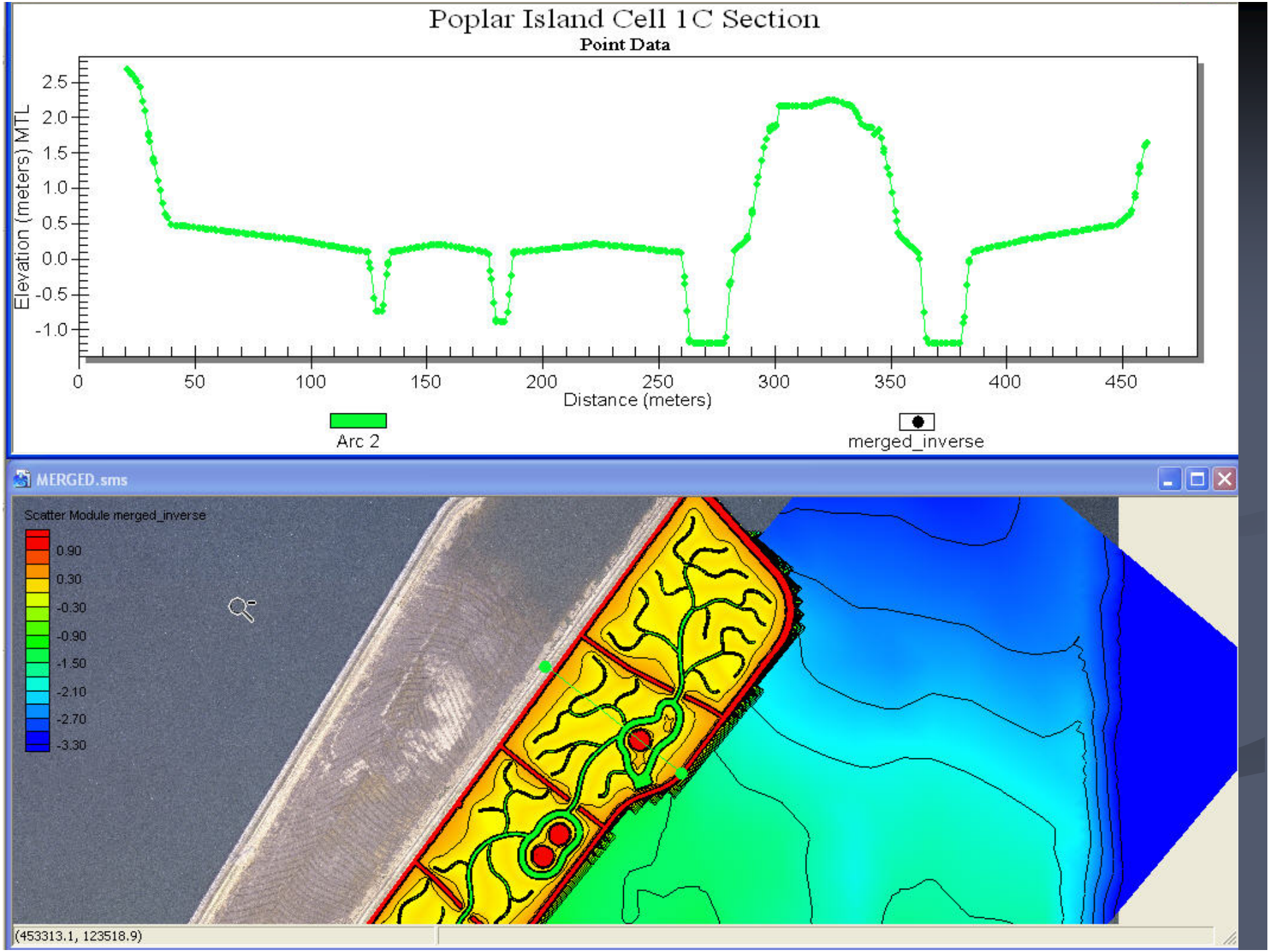


Alt 5
- "C-shaped"
- 150 ft wide
- 100 acre cells
- Bird islands within cells

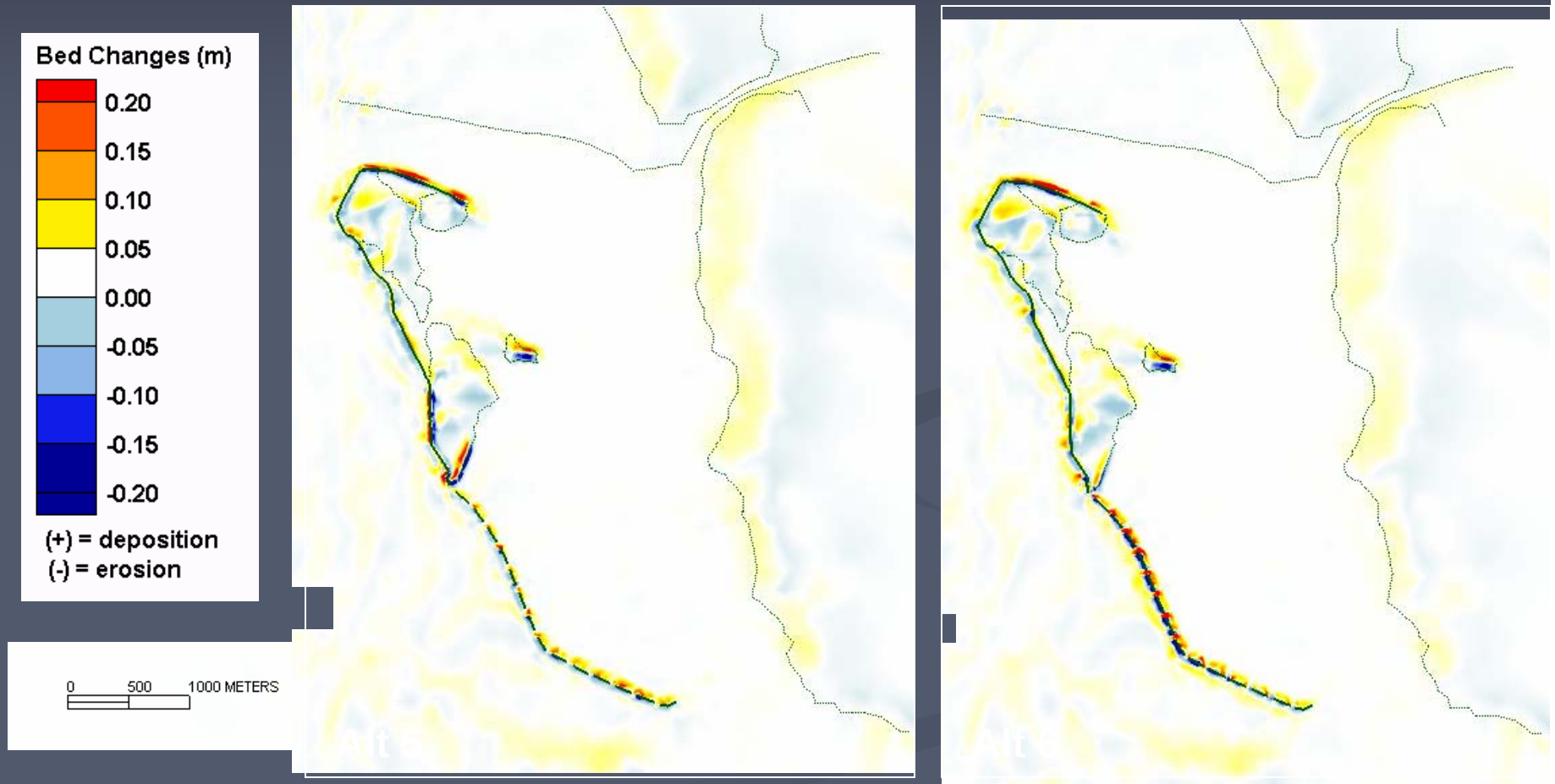


Alt 6
- "C-shaped"
- 300 ft wide
- 100 acre cells
- 4-acre bird island at inlet


Poplar Island Wetland Cells
Water Surface
Elevation (meters) MTL
0.2
0.1
-0.0
-0.1
-0.2
0
5
10
15
20
25
30
35
40
45
Time (hours)
Point 1
Point 2
Point 3
Point 4
Point 5
Point 6
Point 7
Point 8
Point 9
Point 10
Point 11
Point 12
untitled.sms
CGrid Module mod_bound_mag : 33.000
0.50
0.40
0.30
0.20
0.10
0.00
-0.10
-0.20
-0.30
-0.40
-0.50
Vector Legend
0.77 m/s
0.00 m/s
(450048.0, 123844.0)
Cell info: 1 selected; Area = 25.000000 m^2; Volume = 5.235212 m^3; id = 16323; i = 59; j = 51; dx = 5.000000; dy = 5.000000.


Poplar Island Cell 1C Section
Point Data
Elevation (meters) MTL
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
0
50
100
150
200
250
300
350
400
450
Distance (meters)
Arc 2
merged_inverse
MERGED.sms
Scatter Module merged_inverse
0.90
0.30
-0.30
-0.90
-1.50
-2.10
-2.70
-3.30
(453313.1, 123518.9)

Sediment Accretion/Erosion During Hazel
Barren Island Alternatives 5 & 6



Future Coastal Ecosystem Projects in the Chesapeake Bay

- Innovative shoreline stabilization approaches
  - Vegetative approach for lower energy shorelines
  - Combine structural and vegetative approaches for higher energy shorelines
  - Living Shorelines
- Sea Level Rise Strategies
- Regional Shoreline Management Plans
- Interagency Collaboration
- Data sharing
- Monitoring


QUESTIONS?